BOOK REVIEW

GERHARD GOTTSBERGER and ILSE SILBERBAUER-GOTTSBERGER. 2006. **Life in the Cerrado: a South American Tropical Seasonal Ecosystem. Vol. I. Origin, Structure, Dynamics and Plant Use.** (ISBN 3-00-017928-3, hbk.). Abteilung Systematische Botanikund Ökologie und Botanischer Garden, Universität, Ulm, GERMANY (**Orders:** http://www.cerrado.eu/avail.html)**.** €49.00 ($64.60), 277 pp., numerous color figures, drawings, and tables, 8⅝" × 9½".

GERHARD GOTTSBERGER and ILSE SILBERBAUER-GOTTSBERGER. 2006. **Life in the Cerrado: a South American Tropical Seasonal Ecosystem. Vol. II. Pollination and Seed Dispersal.** (ISBN 3-00-017929-1, hbk.). Abteilung Systematische Botanikund Ökologie und Botanischer Garden, Universität, Ulm, Germany**.** (**Orders:** http://www.cerrado.eu/avail.html)**.** €59.00 ($77.78), 385 pp., numerous color figures, drawings, and tables, 8⅝" × 9½".

This authoritative monograph on one of the most remarkable ecosystems of the Neotropics is based on more than 35 years of field work and research by the two authors. It gives not only a survey of the main results of their own multidisciplinary studies, but offers an up-to-date and competent synthesis of the relevant and voluminous literature, often not easily accessible and partly written in Portuguese. The text is well organized and very clearly written, copiously illustrated by many excellent colour photographs and drawings, and supported by numerous schemata and tables.

Volume I covers the more general aspects of the cerrado biome and starts with chapters characterizing the eco-geographical and floristic position of the Central Brazilian cerrado. Relationships are discussed with the Amazonian, Guiana and Central American savannas and the caatinga to the North and Northeast, as well as the Pantanal and Beni savannas, and the chaco and campo rupestre ecosystems towards the West and South. The cerrado and other South American savanna types developed as a consequence of climatic changes from the Miocene (about 25 mya bp) onward. During the Pleistocene they had a much more extensive distribution relative to the tropical rain forests. An important difference with respect to comparable African ecosystems is that large and mostly ungulate herbivore mammals had died out in South America by the early Postglacial. For many flowering plant families and genera (e.g., palms, *Annona*, *Jacaranda*, etc.) an origin of cerrado taxa from tropical rain forest ancestors can be demonstrated. There is impressive fossil evidence for an increase and final dominance in the cerrado grass flora of better adapted C_4 over less specialized C_3 taxa from 10 to 3mya bp. Species diversity is remarkably high in the cerrado flora: For one hectare plots 350–400 vascular plant species are recorded, including 50–90 shrubs and trees. For the whole cerrado area one estimates about 10.000 species. Annual changes of pronounced dry and rainy seasons, and regular fires dominate the cerrado ecosystem. This influences its vegetation rhythm, physiognomy and life form spectrum, and explains the frequent occurrence of excessive bark formations and subterranean xylopodia. Thus, cerrado has an excellent regeneration capacity. Literature reports and personal contacts with Kayapó and Xavante Amerindians reveal the many ways in which cerrado plants are used as fire wood, food, medicine, game attractant, fertilizer and for cultivation by the natives. Remarkable is their management of artificial forest islands in which they concentrate useful plants (also from outside of the cerrado). This contrasts with the destruction of cerrado areas by modern developments which had reached 37% already in 1990 and is sadly accelerating since. Thus, immediate measures are necessary, to preserve at least parts of this unique ecosystem.

Volume II concentrates on the reproductive biology of the flowering plants of the cerrado biome. After an introduction, a first major block of chapters deals with pollination and breeding systems, another with seed dispersal. For not less than 625 cerrado species of flowering plants more or less detailed descriptions and partly illustrations of pollination modes are presented, including references to many hundreds of pollinating animals. Data are arranged according to the following principles: flowers of generalist versus specialist nature; pollinators either collecting pollen, nectar or oil; small to large bees, beetles, butterflies, moths and flies, as well as hummingbirds and bats as pollinators; wind pollination. –Flowering plant spectra of different pollination modes for the single Botucatu plot versus the whole of the cerrado area demonstrate: The majority of species are melittophilous and dependent on small (22/26%) and large bees (16/24%); generalist taxa come second (37/22%), followed by anemophilous (13/4%) and ornithophilous (2/7,5%) taxa, whereas all others remain below 5%. This spectrum differs from other biomes, e.g. from the tropical rain forest where more ornithophilous and less anemophilous species occur. Of particular interest are chapters concerned with families and genera which exhibit evolutionary radiation in response to different pollinators and different flowering periods. A good example is the *Vochysiaceae* which have differentiated from large bee to small bee, hawkmoth and hummingbird pollination. The *Bignoniaceae* are represented by a group of 6 genera with 10 species in the cerrado which produce pollen and nectar and are pollinated in different proportions by 74 bee species. In addition *Jacaranda* has specialized in the production of perfumes from glands at the large staminode, attracting Euglossine bees. Among 19 cerrado species of *Annonaceae* 13 belong to the genus *Annona* and are pollinated by large scarab beetles, whereas 6 species from other genera have smaller beetles and thrips as pollinators. The *Annona* species attract a similar spectrum of scarab species by floral heating and strong odor emission in the evening, but are differentiated with respect to their flowering seasons throughout the year. The 9, mostly short stemmed cerrado palms (*Arecaceae*) studied, are pollinated partly by bees, partly by beetles, but only rarely by wind. Comparative analyses of the

breeding system are another important approach, relevant for evolutionary differentiation: 6–15% of the cerrado taxa studied are dioecious, among the hermaphrodite and monoecious taxa 40–50% are reported as self-compatible and 6–8,6% as apomictic A remarkable set of data is presented on different seed dispersal modes among 301 flowering plant species in the cerrado area of Botucatu. Generally, there is more zoochory (64%, mainly endozoochory) and anemochory (34%), but less autochory (2%) in the tree layer as compared with the ground layer. Endozoochory is even more dominant in trees of the tropical rain forest. Epizoochory greatly declines from the more open cerrado sesu stricto (21%) to the quite dense cerradão (1%). Most of the larger animals involved in seed dispersal (birds, mammals and bats) live in the gallery forests adjacent to the cerrado. Further chapters deal with interactions of flowering plants with herbivores and fungi with as well as with ants and termites.

In retrospect: The two volumes on the cerrado ecosystem by Gerhard Gottsberger and Ilse Silberbauer-Gottsberger are a major contribution to our understanding of the biological problems of South America and a must for all interested in this field. Beyond that these volumes are an important step forward in current efforts to better evaluate the links between species diversity, ecological interdependences and evolutionary aspects in the different biomes of our biosphere.—*Prof. Dr. F. Ehrendorfer, Institute of Botany, University of Vienna, A-1030, Rennweg 14, Vienna, Austria, friedrich.ehrendorfer@univie.ac.at.*